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Moving from Broadcast Television to Mobile Broadband: The FCC's 2016 Incentive Auction

By Gregory Rosston and Andrzej Skrzypacz

Wireless communications have changed dramatically since the early 1980s. Car phones soon gave way to more portable cell phones that developed into the smartphones that seem ubiquitous today. The need for wireless access to the Internet was miniscule before the 2007 introduction of the iPhone. But demand has exploded and will only increase as new applications and uses spring from the Internet of Things.

There are three ways to increase the capacity of wireless networks: increase the amount of frequency reuse (through cell splitting and densification); use more advanced technology that can carry more traffic (by moving from analog to digital and to increasingly technically efficient digital technologies); and increase the amount of spectrum available to these wireless networks.

On March 29, 2016, the Federal Communications Commission is scheduled to begin an auction intended to increase the amount of spectrum available for wireless broadband. Over the past three years, the FCC worked with Stanford economics professors and SIEPR scholars Paul Milgrom, Jon Levin, and Ilya Segal as their principal advisors (with additional help from Larry Ausubel of the University of Maryland and Kevin Leyton-Brown of the University of British Columbia) to design a novel and complex auction to transfer spectrum efficiently. If it works well, most consumers will benefit from higher quality and lower prices for wireless broadband, while there will be some reduction in low-value over-the-air television signals.

Governments around the world

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We have provided auction advice to T-Mobile in connection with this auction.

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have tried to help satisfy at least part of the increasing demand for wireless communication by making available underutilized frequency bands of radio spectrum. However, in most countries most of the useful (and especially low-frequency) spectrum has been allocated to license holders or government agencies so that providing more spectrum to wireless broadband providers means somehow freeing up spectrum from some other use. Historically, the government was able to take back spectrum, reallocate it from government use, or provide alternative spectrum for the incumbents. However, such mechanisms may not work as well with valuable low-band spectrum because there is a shortage of that kind of spectrum given the multiple users operating in it now and the lack of clear substitutes.

At the same time as the explosion in demand for mobile wireless services, some older wireless services are being used less intensively. Over-the-air television broadcast was once the only way to watch TV, but today about 90 percent of households in the U.S. use cable or satellite television service. This suggests that the value of spectrum to TV stations may be lower than its value for wireless broadband. Moreover, TV stations with over-the-air viewers may be able to continue serving their audiences

while using spectrum more efficiently. Indeed, today's digital broadcast technologies allow two or more stations to share a single channel while still broadcasting high-definition programming — a benefit of the move in 2009 from analog to digital broadcast signal, but one that has so far not been used by many broadcasters.

Television frequencies, especially the UHF frequencies between about 600 MHz and 700 MHz, have characteristics that make them particularly well suited for mobile broadband uses. The frequencies in this range propagate particularly well in comparison with the higher frequencies on which many current wireless networks operate. Signals on these frequencies can penetrate the walls of buildings in dense urban areas to provide in-building coverage. In sparsely developed rural areas, the same frequencies travel farther and also pass through the leaves and trees and raindrops that dissipate signals at higher frequencies, reaching homes and farms and roads that are far from transmission towers. These frequencies can be received with small antennas that fit into mobile phones and avoid interference from low-frequency household appliances.

Based on the prices in recent spectrum auctions and increases in consumer surplus, tens, or

possibly hundreds, of billions of dollars of value can be unlocked by transitioning underutilized television spectrum to higher value uses. Some have argued that the FCC should have pursued this goal by refusing to renew television broadcast licenses and eventually reassigning the spectrum to wireless broadband use. However, this approach was not favored by broadcasters, many of whom paid tens or even hundreds of millions of dollars for their stations and had an “expectancy of renewal” for their licenses. Alternatively, the FCC could have allowed direct sales of TV licenses to mobile wireless telecommunications providers, with a process for expanding the allowable use.

However, efficient use of spectrum requires minimizing cross-service interference, which requires clearing a contiguous swath of spectrum in terms of both geography and frequency. A free-market approach to spectrum reallocation could have been susceptible to “hold-out” TV stations blocking valuable mobile spectrum in high-density areas. It could also suffer from major coordination issues since there is a technological benefit from creating a nationwide uniform or close to uniform use of the band (so that one antenna in the phone can provide service in this spectrum in the whole country).



As a result, the FCC concluded the best path to repurposing this valuable spectrum would be to run a voluntary two-sided “incentive auction,” allowing simultaneously for the sale of some television licenses back to the FCC, the reassignment of remaining television stations into a narrow set of channels, and the sale of newly created wireless licenses to telecommunications firms. In 2012, Congress authorized the FCC to proceed with this plan. The auction scheduled to begin in March will possibly continue for a few months.

Designing an Incentive Auction

The U.S. incentive auction is the first attempt anywhere in the world to provide a cash incentive to licensees to return their spectrum rights to the government so spectrum can be repurposed. The money to pay for that must ultimately come from buyers of newly created broadband licenses. An obvious first question is whether the basic economics can work out: Will broadcasters sell at the prices telecommunication firms might pay?

It seems clear that cash can be a good inducement to for-profit broadcasters, but what about the so-called “mission broadcasters,” like universities, public television stations, and religious broadcasters? Many of these are finding that they can carry out their missions effectively by

sharing a channel with another broadcaster, or by switching to a VHF channel. (Either option would preserve their “must-carry rights,” which allow them to demand free carriage by the local cable and satellite providers.) Another option would be to cease over-the-air broadcasting and rely on Internet broadcasting. For such mission broadcasters, the auction provides a prospect of raising money to enhance their programming and increase financing for other aspects of their mission.

On the telecommunications side, demand for spectrum has been very high. In the fall of 2014, the FCC auctioned spectrum licenses in the (higher) AWS-3 band. The auction generated more than \$40 billion in revenue from firms such as AT&T and Verizon. If mobile wireless providers were to offer, say, \$50 billion for 70 MHz of licenses in the potentially more valuable UHF band (the AWS-3 auction involved licenses covering 50 MHz), the revenue would suffice to offer television stations on average around \$20 for each person in the station’s broadcast area. These types of (highly) approximate calculations have captured the attention of broadcasters during the run-up to the auction.

However, to unlock this value, the auction needs to solve a daunting engineering

challenge. In order to clear some of the channels that are currently reserved for UHF-TV broadcasting (14-51, starting at the upper end and working down), the stations that continue their over-the-air broadcasts must be retuned and packed into a smaller set of channels (from channel 14 up to 29 or 36, for instance). There are roughly 2.7 million constraints that must be respected to avoid creating interference among the remaining broadcasters. And since radio broadcast signals do not respect national boundaries, the U.S. reorganization also needs to be coordinated with Canada and Mexico. Never in history has such a complex resource allocation problem been managed by an auction procedure.

Apart from the international coordination and the millions of interference constraints involved in repacking stations, there is a need to use bids by the stations to determine which stations to buy and how many channels to clear for the new uses. The same channels need to be cleared across the nation, so that individual user devices can know which frequencies are available to use, and the clearing needs to be roughly simultaneous, so that the service providers can roll out a uniform service across the whole nation and market it to users. Managing all of this together requires close

coordination of many parties as well as methods to set standards and resolve disputes.

For the government, there was another critical challenge — making sure the auction would be understandable and accessible to the bidders, including many small broadcasters who might wish to sell rights. Whatever bids are made in the auction to sell stations, the government auctioneer needs to figure out which stations to buy and for what prices, and the sellers may include many who do not trust the government’s computation. The design team worked with the FCC to find auction rules and algorithms that both perform well and make it simpler for broadcasters (especially small single-station owners) to bid in the auction.

Innovations in Auction Design

The incentive auction has several novel features. There is an entirely new auction involved in buying licenses back from some TV stations and repacking the ones that decide not to sell. In addition, the auction includes rules for selling broadband licenses and for determining how many channels to buy and licenses to sell. If one speaks about the auction loosely in Econ 1 terms, the “reverse auction” to buy broadcast licenses elicits a supply curve for spectrum, the “forward auction” to sell

mobile licenses elicits a demand curve, and the “clearing rule” determines how much spectrum will be traded based on demand and supply.

To set the prices that will be offered to broadcasters, the FCC will use a new descending-price auction format. Each station initially will be offered a high price to induce it to participate in the auction. Then, if there is competition to relinquish licenses in a given area, prices will fall until the stations most eager to sell (based on their willingness to accept low prices) are identified. From the perspective of the stations, the auction is simple — a station owner just sees a sequence of declining price offers and must decide at what point she or he would prefer not to sell (or move to a lower spectrum band).

Under the hood is a very complex set of calculations, figuring out in each round for any given participating station whether it would be feasible to reject this station’s bid while still clearing the desired number of channels. Only if the answer is proved to be “yes” may the price offer to the station be reduced, giving the broadcaster the opportunity to exit the auction and continue broadcasting if it does not find its new offer attractive.

The selling auction also incorporates a set of novel features, the most novel of which

is called the “conditional reserve.” This rule limits the ability of the largest buyers to acquire all of the low-frequency spectrum. The intent of the rule is to ensure that multiple companies will have access to this spectrum so that they can participate and compete effectively in the market for supplying broadband services. In some past auctions, regulators have tried to achieve this goal by setting aside spectrum for smaller players. In the incentive auction, a pure set-aside approach has a potential weakness — setting aside spectrum could lower revenues so much that it might prevent the government from being able to pay the broadcasters and complete a successful transaction. The novel conditional reserve sets aside spectrum for new participants, but only if they bid high enough that the selling broadcasters can be paid at the clearing level.

The last of the novel rules is the one to determine how many channels the auctions will make available for broadband uses. The number of channels to be bought is called the “clearing target,” and associated with each such target is a number of broadband licenses that can be offered for sale. To begin the auction, the FCC will target a relatively ambitious amount of spectrum to reallocate, constrained only by the initial participation of

broadcasters at the opening prices. The auction to buy TV stations will proceed with prices falling, and the auction to sell broadband licenses will proceed with prices rising. If when these auctions end, the results are compatible — with the revenue from telecommunications firms exceeding what must be paid to buy the television licenses — and if the forward auction prices exceed a minimum reserve price threshold, the overall auction will end. If not, the clearing target will be reduced. Prices will continue to fall for the TV stations and rise for broadband licenses until a sale is possible.

How Will It Work Out?

If the auction goes well, hundreds of television stations will relinquish their broadcast rights or move into channel-sharing arrangements or move to new channels. Of course, these

stations will still be able to reach viewers over cable or satellite or the Internet and, because the auction is voluntary, no station owner should be worse off. At the same time, telecommunications companies will have more low-frequency spectrum to build their networks, improving wireless broadband and — if the conditional reserve rule works — hopefully leading to even more competition among providers with high-quality coverage.

That competition should lead to lower prices for consumers and better broadband coverage. Arguably, one exception to the win-win-win design are the few unlicensed users who had taken advantage of the so-called “white spaces” between broadcast channels to make free use of under-utilized spectrum. Even these losers receive some protection in the FCC’s plan,

which sets aside spectrum for unlicensed uses in most areas of the nation.

There are others, including the trade association for some broadcasters, who are not happy with the plan to reduce over-the-air broadcasting and have attempted to stop or delay the process. Finally, some households who rely on over-the-air broadcasting will have fewer over-the-air choices but will have other avenues such as the Internet to access video content.

However, we hope that the auction will proceed as scheduled. If the auction lives up to its promise, consumers will benefit not only from this efficient reallocation of spectrum and increase in competition but from other market-oriented spectrum reallocations that may come about in the future.

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